From: Andrew Allsop <andrew.allsop@arup.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 8/1/2005.

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Report Number : NCSTAR 1
Page Number : 203
Paragraph : 9.2.1. Recommendation 2
Comment : Arup are responsible for organising and quality review of a large number of wind tunnel studies on projects around the world and have observed and done our best to correct a number of problems with wind tunnel testing similar to those observed by NIST. These have involving variety of different laboratories, including those in N.America.

It is many years since the Aylesbury Experiment was carried out and revealed very significant differences in mean and peak cladding pressures caused by differences in choice of wind profile, turbulence intensity and static reference pressure. This was useful, enabling some laboratories at least to tighten their procedures. There are also secondary issues of effects of turbulence length scale, appropriate frequency response of instrumentation and methods of statistical estimation of peak factors.

Measurement of static and dynamic responses using techniques such as the "High-Frequency" Force Balance, flexible and semi-rigid aeroelastic modelling and "simultaneous-pressure" studies are also sensitive to all the above plus directional combinations and the influence of damping when calculating the dynamic responses.

The issues of when and how to use more advanced methods are technically complex and are subject to continuing research and development making it difficult to write down prescriptive rules. (eg see the ASTM "Manual on Wind Tunnel Testing".) Performance based rules are thus used in most international standards with minimal guidance on how to achieve them. This encourages research in these areas and makes it possible to differentiate between the more and less technically capable laboratories, even if it is a little anarchic. In special cases an independent 3rd party review of procedures could be introduced as in other cases where there may be unusual structural reliability issues.

We should also remember that current methods of wind tunnel testing are good for testing a limited range of structures, such as tall and other major buildings, but do less well with housing. Also we currently cannot model thunderstorm gust effects in any realistic way and these are potentially the governing case for smaller structures in many parts of USA.

There is however an urgent need to increase the reliability of procedures for

estimating wind speeds. Most wind tunnel laboratories primary expertise is in the wind tunnel testing process rather than wind climate assessment. In Arup's experience the choice of appropriate design wind speeds is the most significant and worrying cause of the differences between laboratories.

It is an unfortunate fact of life that wind speeds, especially mean wind speeds, are very sensitive to exposure effects, especially near the ground. Taking data from limited numbers of 10m level anemometers in less than ideal exposures and extrapolating to several hundred metres in height is always going to be a difficult, subjective and hence highly unreliable process. It is very easy to end up with results which are significantly out of line with climatological expectations. The best method we have at present for increasing the consistency of results from wind tunnel studies using such data is to achieve a consensus of interested parties on the wind speeds to be used. This is problematic since there is no appropriately skilled forum where such a consensus may be built. The AAWE has members who could form a base for such a forum.

One of the problems here is that most are used to working with highly oversimplified models of how the wind behaves, which do not take account, for example, the effect of changes of ground roughness and topography. There are very different predictions of mean and gust speed variation with height between standards based on the Harris and Deaves non-equilibrium wind model (published by ESDU International and as used by NJ Cook in his analysis of a large number of anemometers in the UK) and those in most international standards including ASCE-7. (eg Gust wind speeds at 150m and above don't actually take much notice of the speed limit signs at the edge of town!)

Very little money has been spent to date on trying to improve this situation. In the case of major cities, it would seem appropriate that high level anemometers are established and maintained as a means of increasing knowledge of winds at high levels. New technologies of remote monitoring, using eg sodar, may be (or become) even more cost effective and robust against storm damage for this purpose.

It is interesting to note that, whereas meteorologists are finding that CFD technology is gradually becoming more capable of modelling meso-scale events such a thunderstorms and hurricanes, the treatment of the bottom km of so of the atmosphere is necessarily still rather messy. We should all be looking for opportunities here.

Recent measurements of damping on finished buildings also do not entirely support commonly assumed design values, especially on slender new concrete buildings where values less than 1% of critical are frequently measured compared with the commonly used 2% (or higher). It is much easier and cheaper to establish frequency and damping data from remote monitoring of ambient vibrations than it was in the past. It may be time to encourage more routine monitoring.

These are matters which concern many if not most in the wind engineering community. Commercial pressures do not always automatically produce the best

answers.
Comment Reason :

Revision Suggestion : Arup suggestion 1: Steps should be taken to create a better consensus of wind speeds at heights important for design of tall buildings, especially in major cities. This should involve as a minimum the ASCE, AAWE and the City Authorities to ensure that appropriate knowledge is used. Some publicly organised funding would be needed.

Arup suggestion 2: Third party detail review of wind tunnel testing procedures and analysis should be routinely undertaken in cases of special risk. In UK speak we would say category 2 (calculation checks by 3rd party) or category 3 (independent evaluation by 3rd party) checks should be undertaken as for structural design in appropriate cases.

Arup suggestion 3: Means of increasing the database of damping measurements of tall buildings should be explored.

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Paragraph : Recommendation 3
Comment : Sway and deflection limits.

The ASCE has recently initiated a study to update guidance on the human acceptability of building motions. This should be encouraged to run its course. It is important that changes introduced as a result of such work are compared to experience with acceptability resulting from use of current methods.

It has been our experience that lateral stiffness rather than member strength has governed the choice and size of main structural elements of tall buildings. Reducing the deflection limits will thus have a significant effect on the quantity of material used in tall buildings. However deflections of themselves do no damage. Apart from the above, deflections are limited in tall building design for the following reasons:

1. To meet arbitrary code guidance.
2. To avoid secondary P-Delta effects which are now routinely included in structural calculations for strength and stiffness.
3. To minimise dynamic wind effects, which are now routinely calculated accurately (with some reservations above) using WT testing.
4. To limit motions which might cause damage to secondary elements, which is caused by inter-storey shear not overall deflection.
5. To avoid buildings striking each other - rarely a problem with tall buildings, but an obvious problem to avoid if it might occur.

One further problem with interpretation of code deflection limits is that they are frequently taken to apply only to serviceability limit states. Clearly it is pointless to design cladding to resist wind loads at the ultimate limit state when it is likely to fail at just above the serviceability limit state once the movement joints have closed up.
Comment Reason :

Revision Suggestion : Arup suggestion: It may be useful to provide better guidance on inter-storey shear limits for which normal cladding and partition units can installed without needing special detailing.